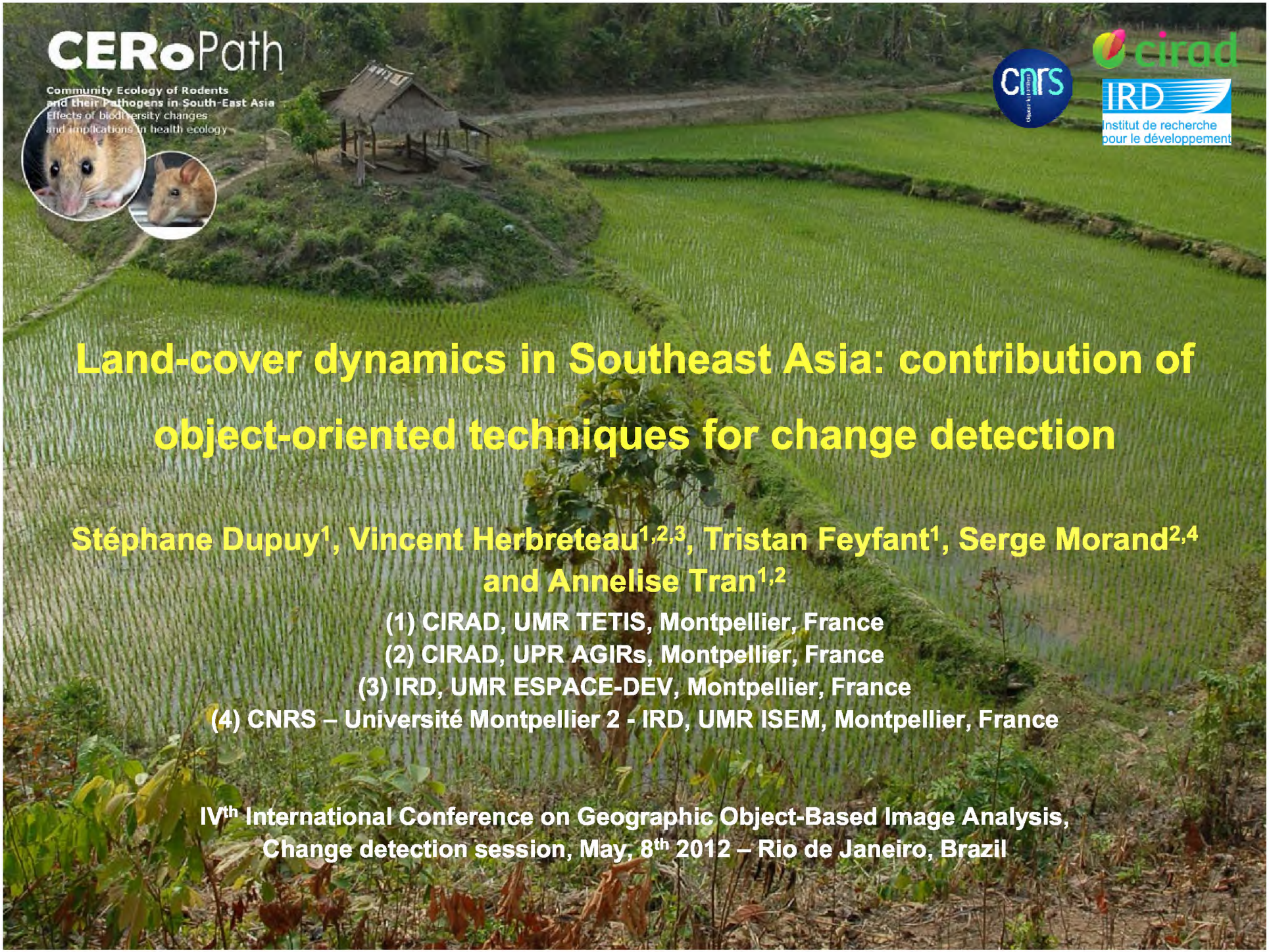

Land-cover dynamics in Southeast Asia: contribution of object-oriented techniques for change detection

Stéphane Dupuy[1], Vincent Herbreteau[1,2,3], Tristan Feyfant[1], Serge Morand[2,4] and Annelise Tran[1,2]

(1) CIRAD, UMR TETIS, Montpellier, France
(2) CIRAD, UPR AGIRs, Montpellier, France
(3) IRD, UMR ESPACE-DEV, Montpellier, France
(4) CNRS – Université Montpellier 2 - IRD, UMR ISEM, Montpellier, France

IVth International Conference on Geographic Object-Based Image Analysis,
Change detection session, May, 8th 2012 – Rio de Janeiro, Brazil

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Community Ecology of Rodents and their Pathogens in South-East Asia
Effects of biodiversity changes and implications in health ecology

Background

CERoPath project (ANR 07 BDIV 012) :

Community **E**cology of **Ro**dents and their **Path**ogens in South-East Asia

www.ceropath.org

→ aiming at understanding the implication of rodents in the transmission of diseases,

→ in a context of **rapid environmental changes**.

Photos: Herbreteau V.

Introduction:

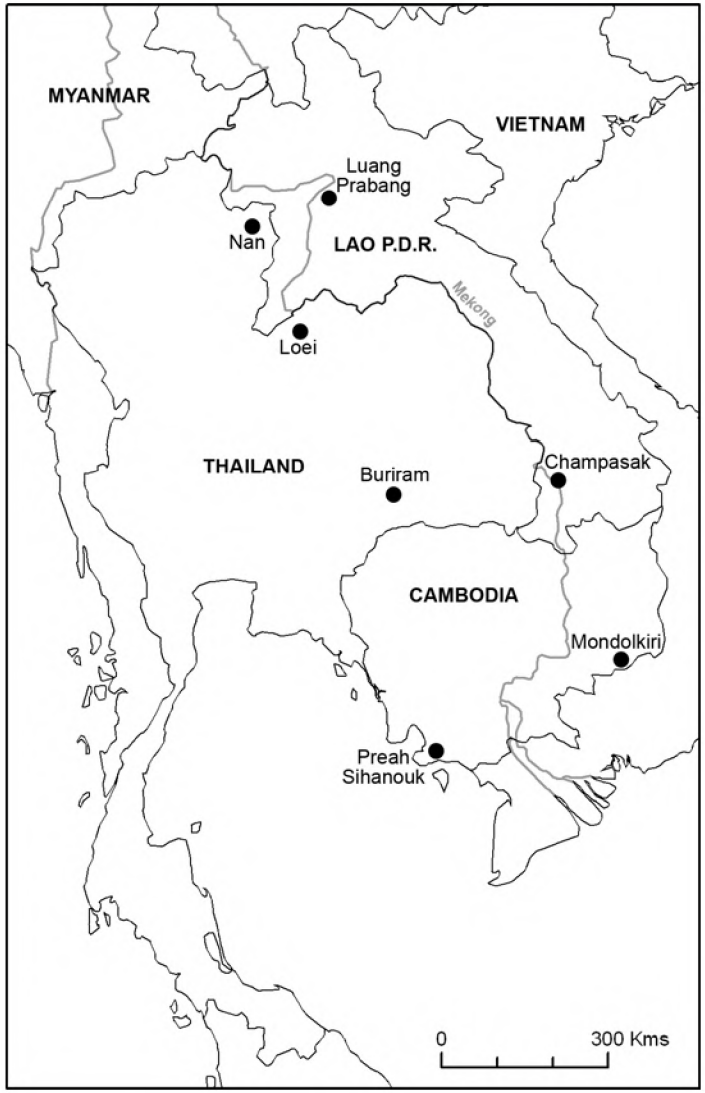
Objectives

Investigation of land-cover changes in South-East Asia

- Seven study sites in Cambodia, Lao PDR and Thailand

- Time period: 1987- 2008

- Assess for each site the location and the rate of land-cover changes

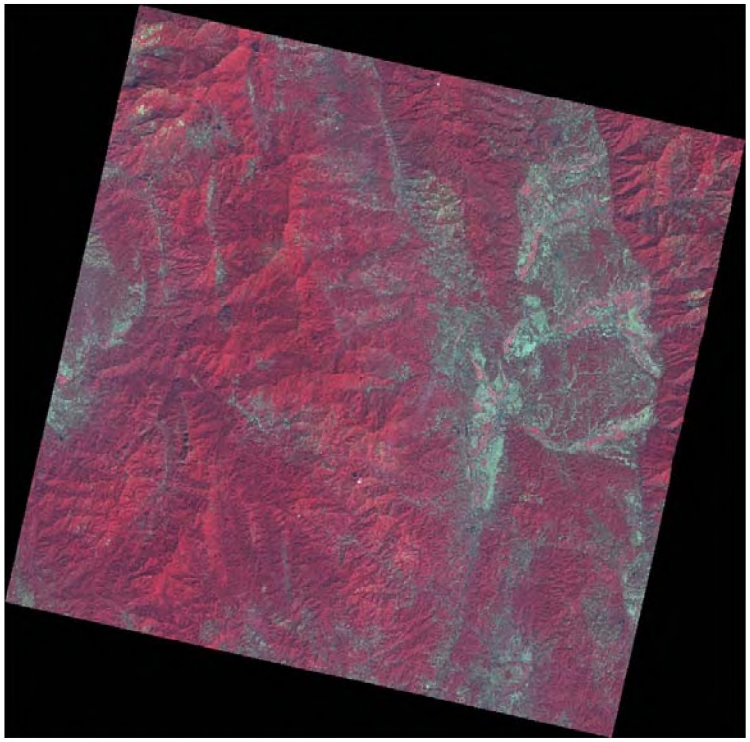


Material and Methods:

Satellite imagery

High spatial resolution multispectral images

- SPOT scenes (PAN: 2.5 m, MS: 10 m)
- Three dates from 1987 to 2008
- As possible, cloud-free scenes



SPOT-5 image of Nan province, Thailand

Digital Elevation Models (DEMs)

- SPOT-DEM (20m)
- Shuttle Radar Topography Mission (SRTM) (90m)

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Material and Methods:

- Image pre-processing
- Image segmentation
- Image classification
- Change detection
- Landscape analysis

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Material and Methods:

Image preprocessing

Radiometric calibrations

- Conversion of digital numbers to reflectance

Resampling

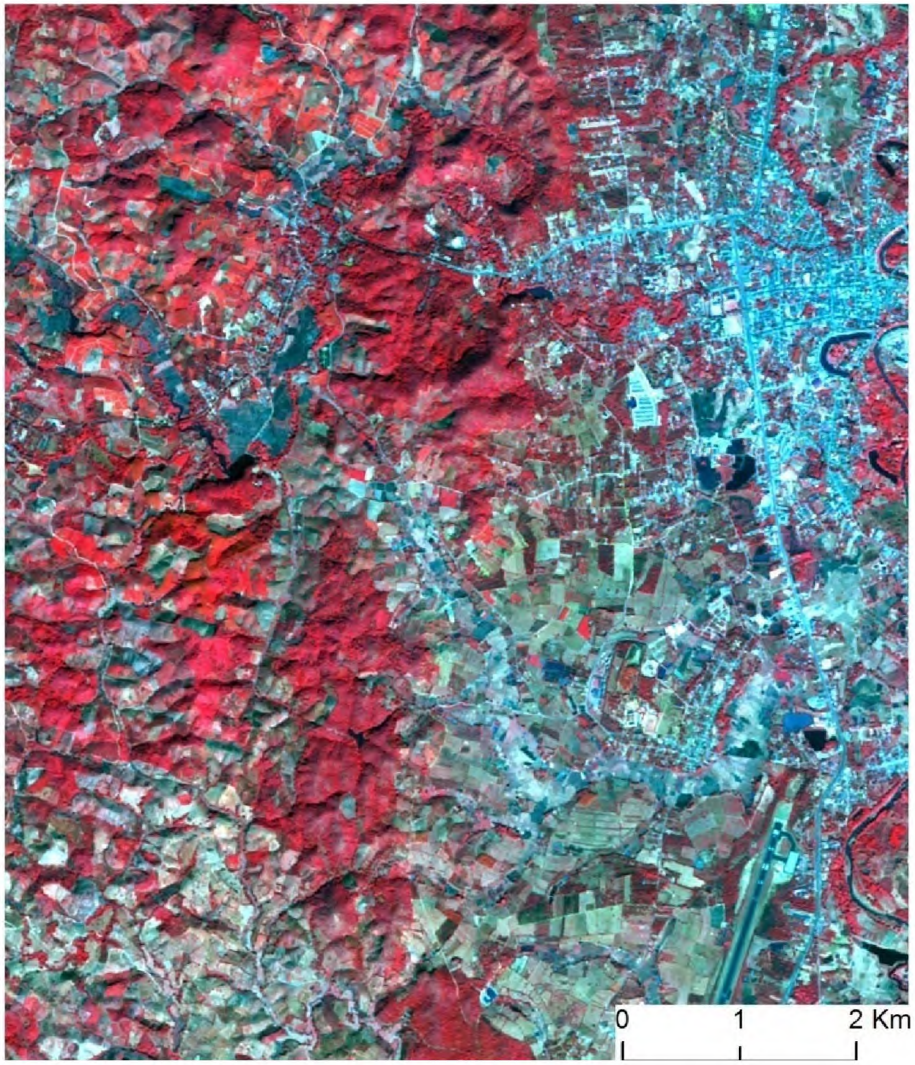
- Resampling the 10 m Multispectral images to 2.5 m resolution of the Panchromatic images.

Texture indices

- Contrast and dissimilarity indices derived from Panchromatic images

Topographic index

- Slope derived from DEMs



SPOT image from Loei province, Thailand

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Material and Methods:

Segmentation

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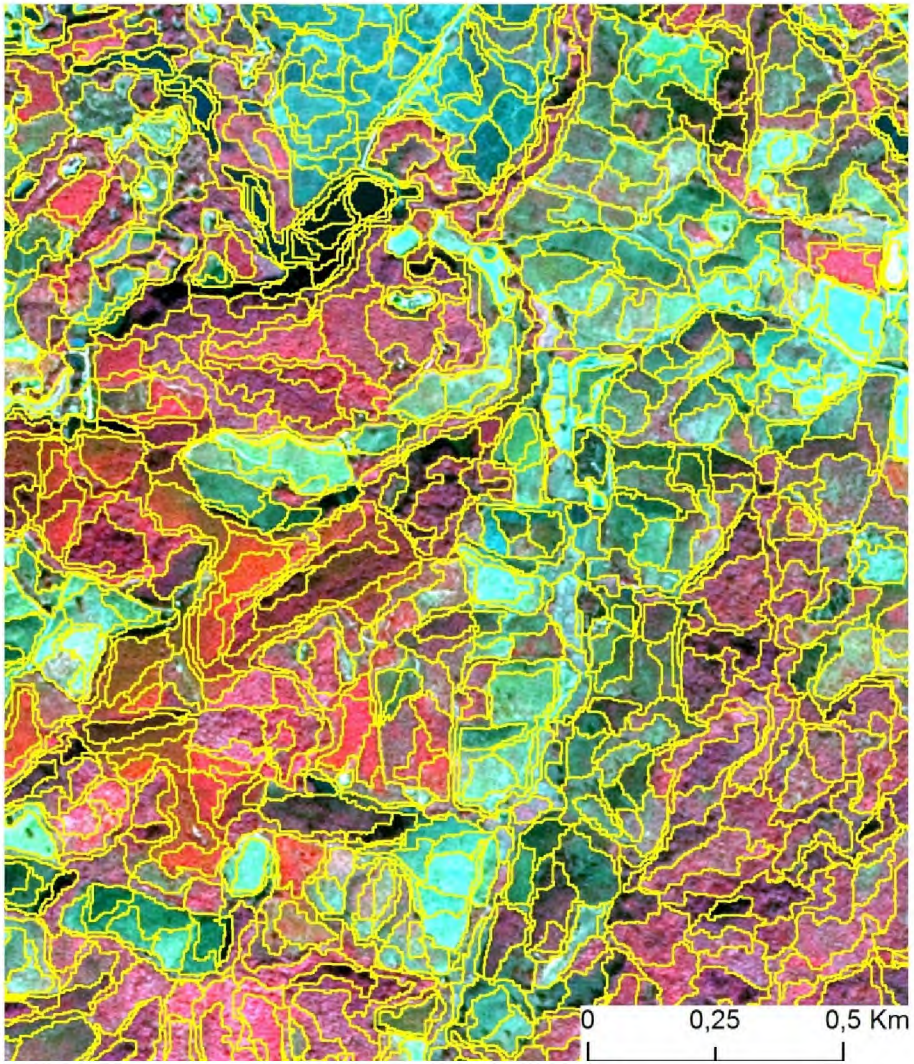
'Multiresolution segmentation' algorithm

- Applied on the most recent scene
- eCognition Developer® software
- Same segmentation parameters for all sites (scale factor, shape and compactness values)
- Two levels of segmentation



Segmentation of SPOT image from Loei province, Thailand

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Material and Methods:

Classification – Level 1

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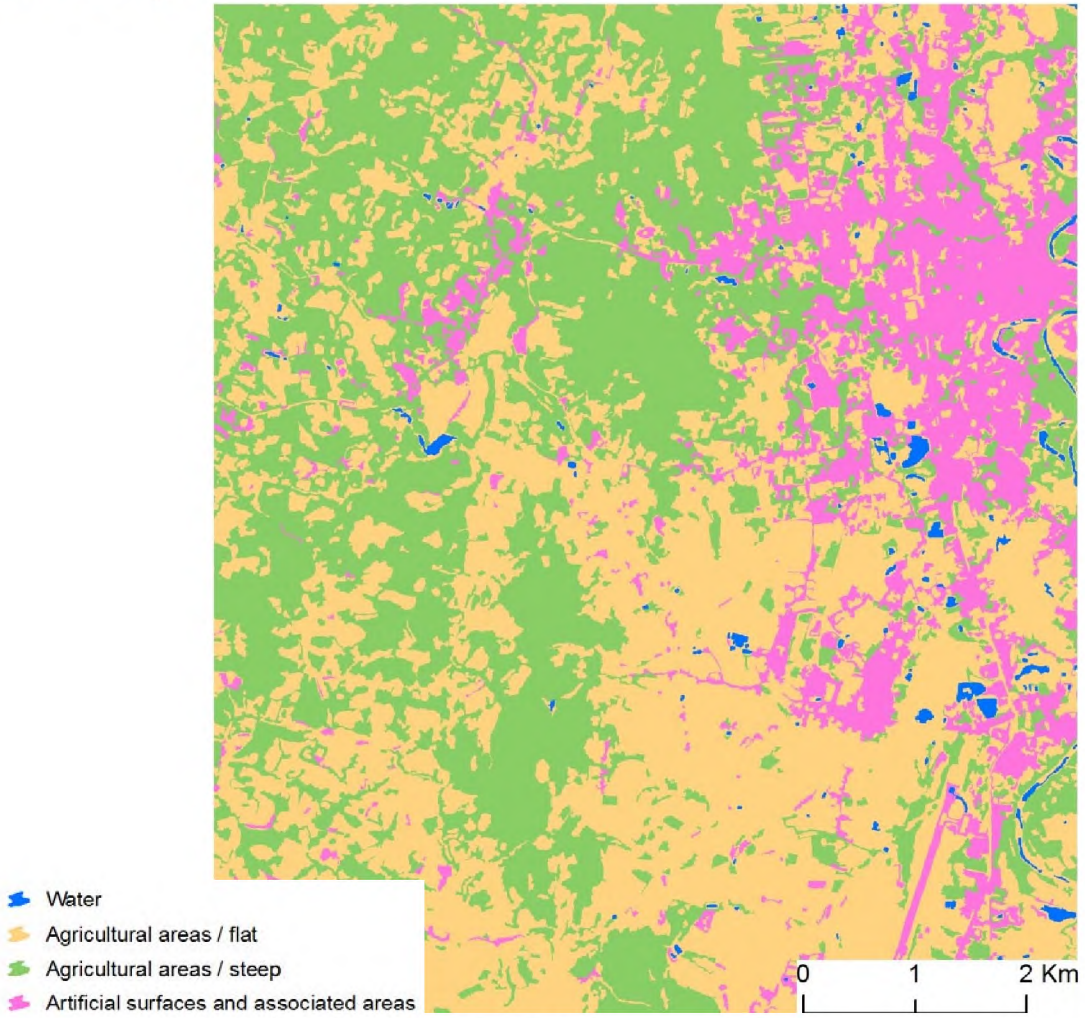
Classification using membership functions

- Objects intrinsic characteristics:
  - Reflectance values
  - Shape
  - Texture indices
  - Vegetation index
  - Water index
  - Slope
- Same characteristics and membership functions parameters for all sites



Level 1 - Classification of SPOT image from Loei province, Thailand

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Material and Methods:

Classification – Level 2

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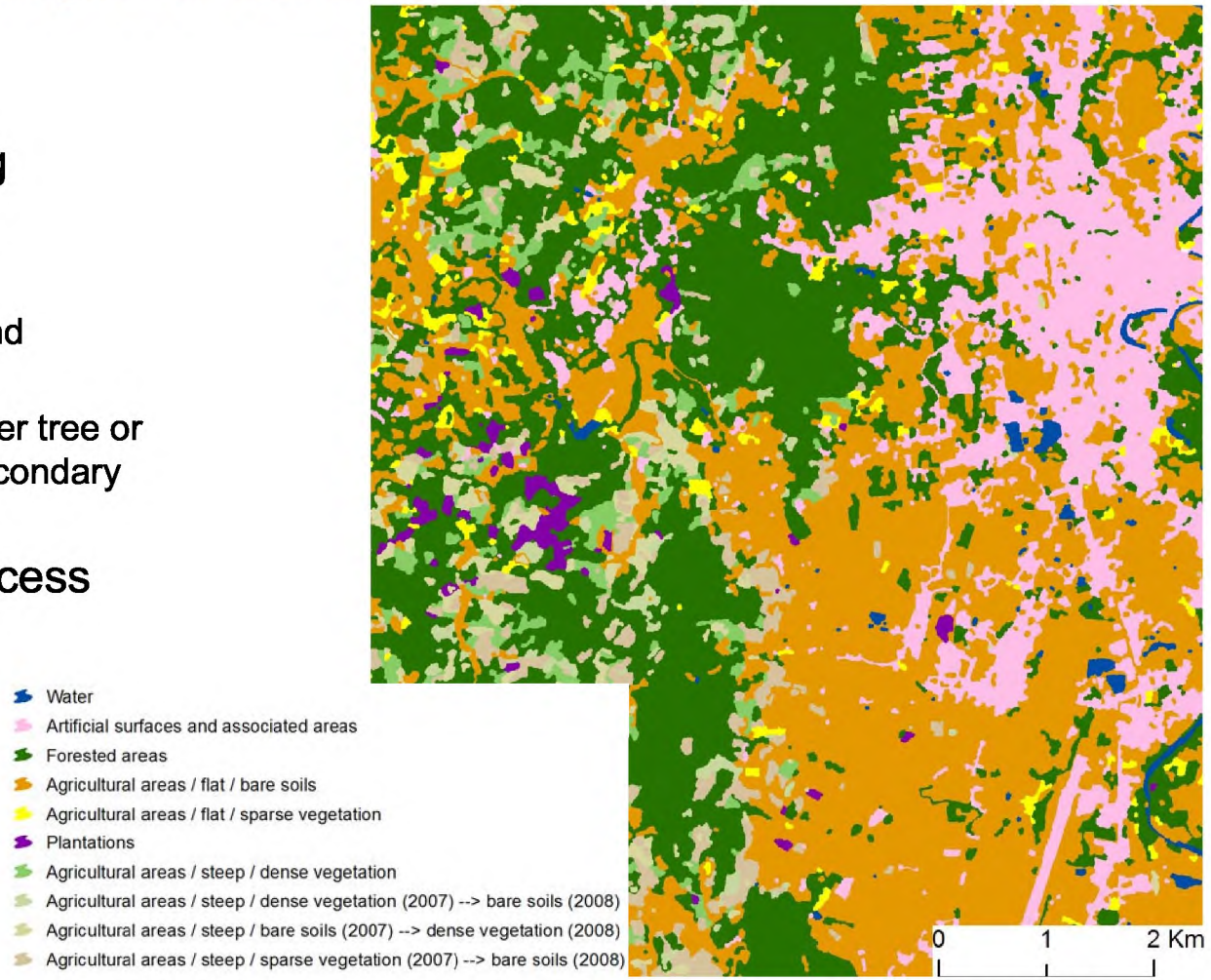
Supervised nearest neighbour classification

- Selection of training samples from field observations:
  - Different wooded and agricultural classes
  - *e.g.* rice fields, rubber tree or teak plantations, secondary tropical rainforest
- Site-dependent process



Level 2 - Classification of SPOT image from Loei province, Thailand

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Material and Methods:

Changes detection

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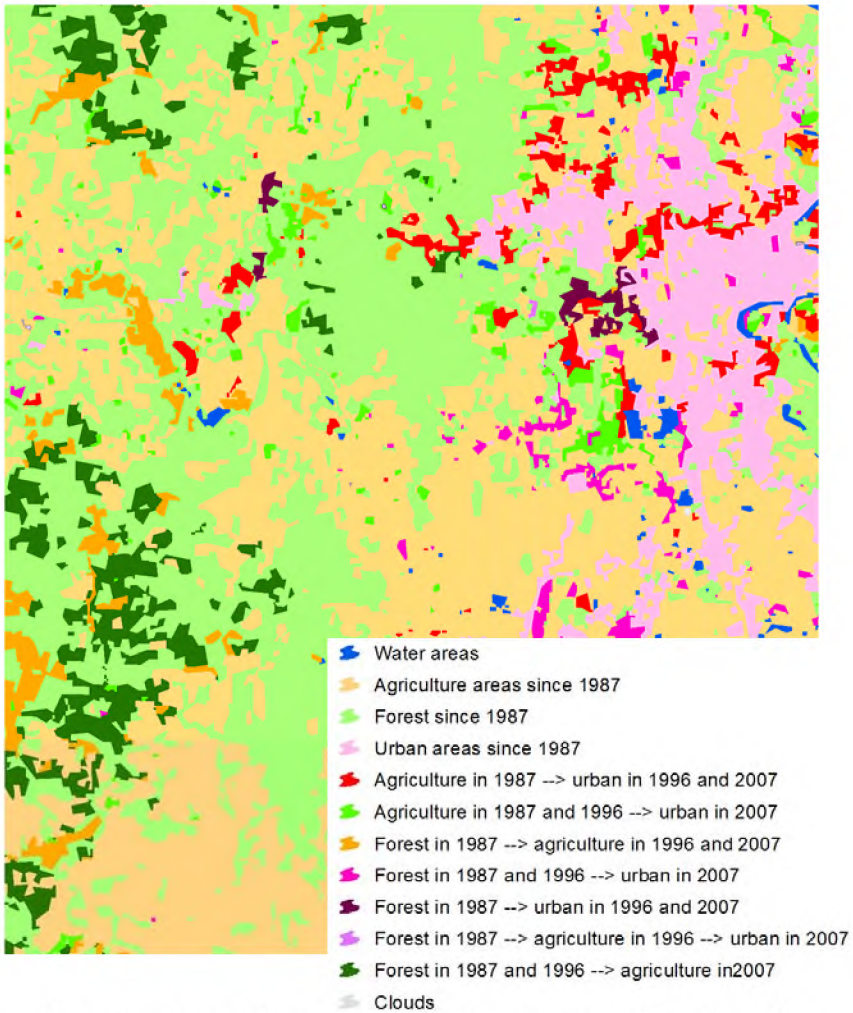
Object-based classification of older scenes

- Merging objects to allow inter-site comparison:
  - Water
  - Wooded areas
  - Cultivated areas
  - Built-up areas
- Segmentation
  - Based on the 4 classes limits
- Classification
  - Intrisic properties
  - Topologic characteristics (relations to neighbouring objects)
  - Contextual characteristics (semantic relationships)



Land-cover changes, Loei province, Thailand

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Material and Methods:

Landscape analysis

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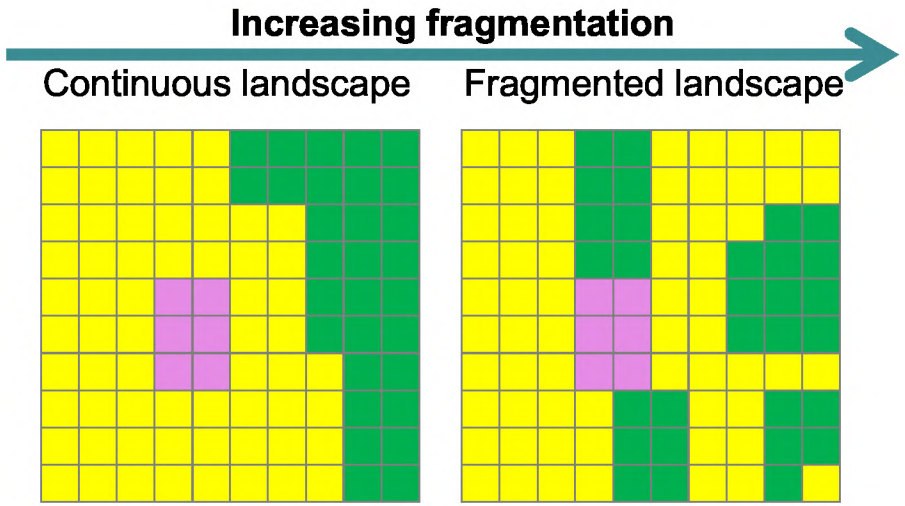
Landscape indices calculation

- Proportion of each land-cover type

Occupation	Area (ha)
Forested area	30
Agricultural area	64
Built-up area	6



- Fragmentation indices
  - Patch density
  - Edge density

$$\text{Edge density} = \frac{\text{Total edge (m)}}{\text{Total area (ha)}}$$

Edge density (m / ha)	0.76	1.24

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Results:

Land-cover maps

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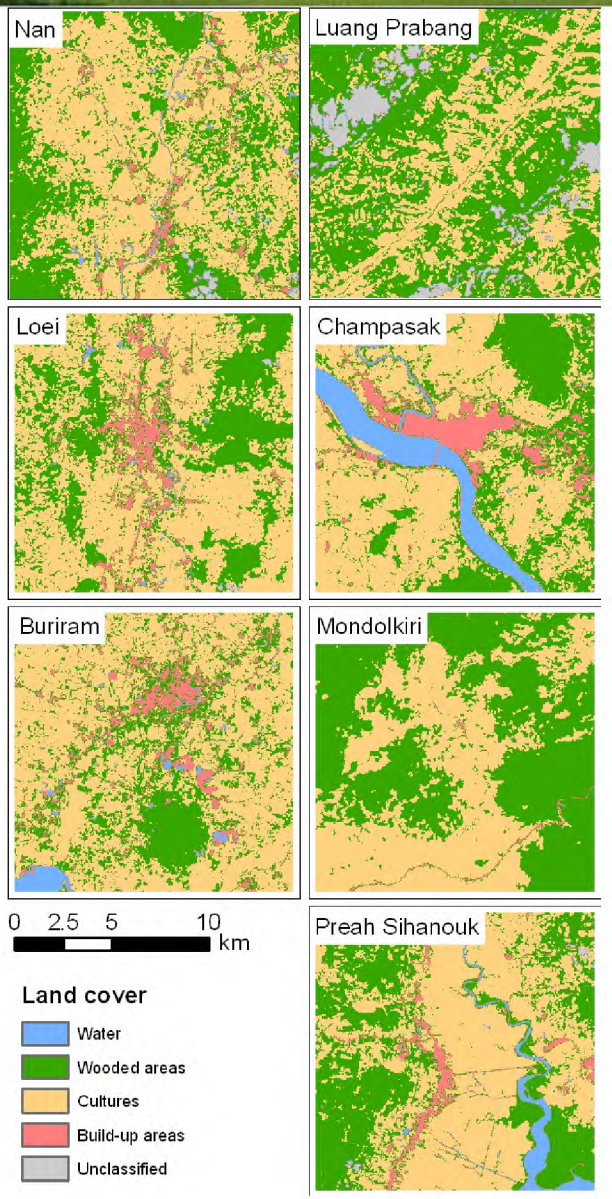
Various landscapes

Photos: Morand S.

- 2 sites largely covered by wooded areas (Luang Prabang, Lao PDR, and Mondolkiri, Cambodia)
- 1 site with limited forested areas (Buriram, Thailand)
- Differences in size of forested patches



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Results:

Land-cover changes

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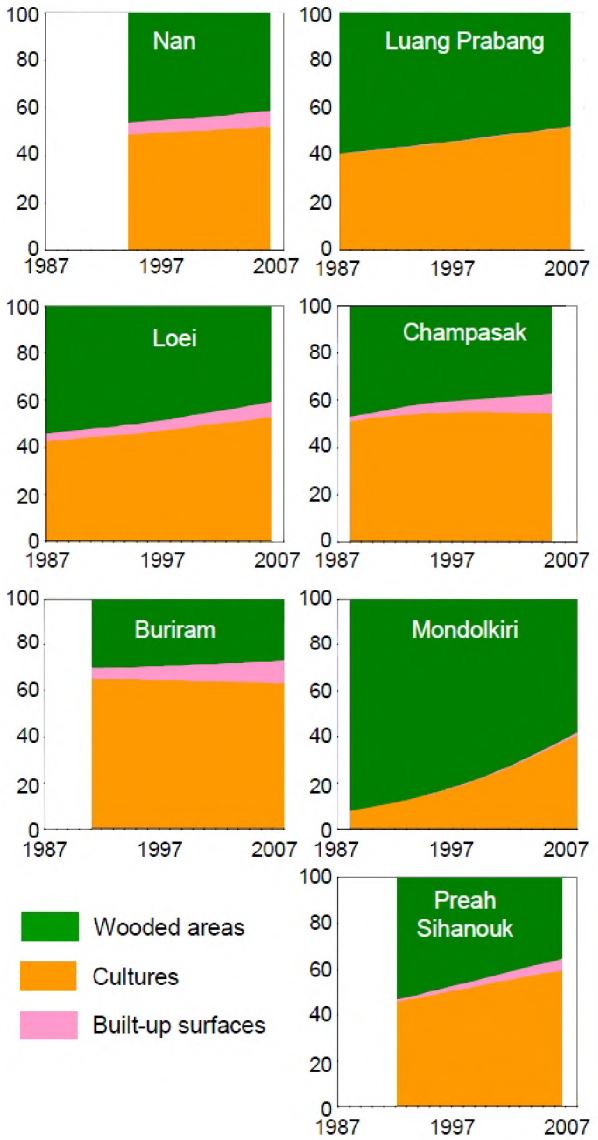
Diminution of forested areas

- All sites
- Estimation of annual deforestation rates: from 0.65% (Buriram, Thailand) to 1.84% (Mondolkiri, Cambodia)
- Major cause: conversion of forest to agricultural land



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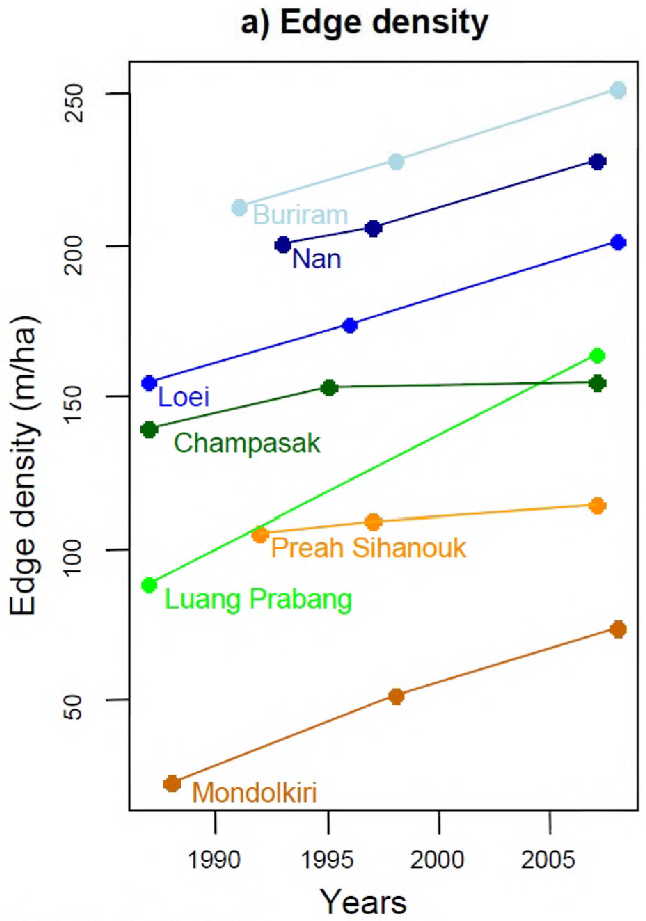
Results:

Landscape analysis

Increase of all landscape indices

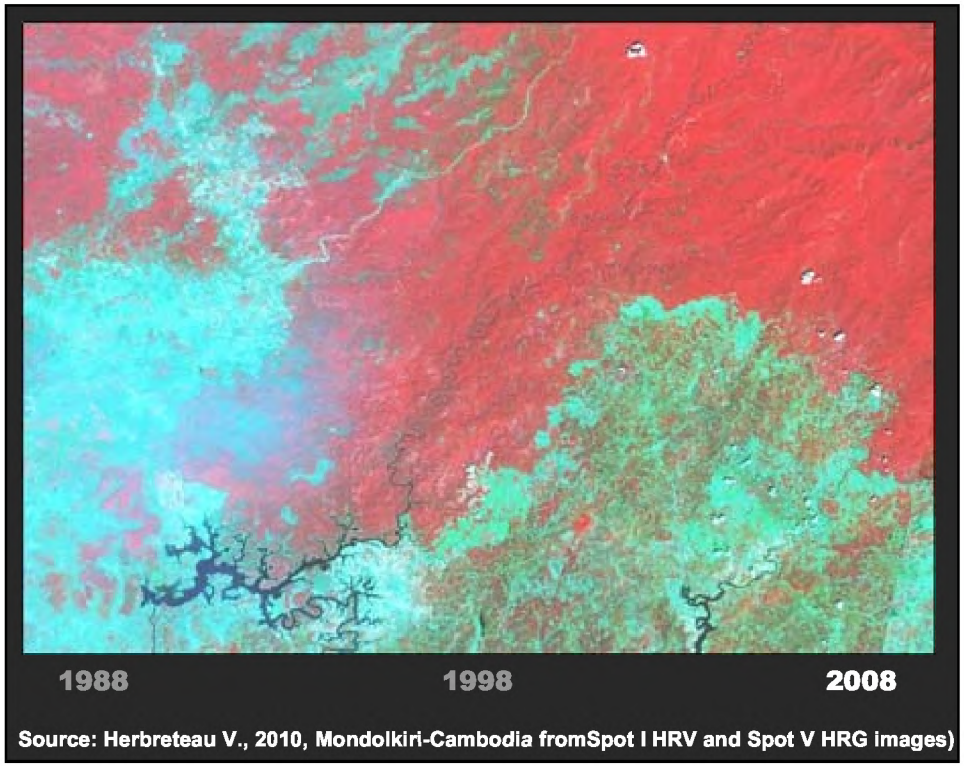
- All sites
- Increase of habitat fragmentation and landscape heterogeneity
- Different dynamics between the three countries
  - Fragmentation higher in Thailand and lower in Cambodia



In blue: Thai study sites
In green: Lao study sites
In maroon: Cambodian study sites

Remote sensing techniques: valuable tools for landscape change monitoring

- Rapid and recent changes



Source: Herbreteau V., 2010, Mondolkiri-Cambodia fromSpot I HRV and Spot V HRG images)

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Discussion and conclusion:

Contribution of OBIA

OBIA: advantages

- Same segmentation and membership functions classification processes to discriminate main classes
- Efficient to process a high number of scenes (25)
- Integration of various indices: texture, slope
- The segmentation prior to object-based classification enabled to avoid obvious errors in classification and thus improve change detection
- OBIA facilitates the calculation of landscape indices

Limits

- High variety of landscapes and land-cover classes -> supervised classification applied to each site based on sample selection

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Discussion and conclusion:

Land-cover changes in Southeast Asia

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Important land-cover changes over the last two decades

- Results consistent with annual deforestation rates estimated by the Global Forest Resource Assessment or other research studies
- Characterization of fragmentation dynamics
- Higher temporal resolution of remote sensing data is required for a proper land-cover changes monitoring

Perspectives

- Socio-economic investigation on land uses to identify underlying driving factors
- Study of the impact of environmental changes on biodiversity of rodent communities

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Acknowledgements

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Thanks for your attention!